Development of Preliminary Design for Tidal Power Plant at Kuching Barrage

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Abstract

Nowadays, the Malaysian government supports the production of electricity from natural phenomenon since non-renewable energy are depleting. Kuching Barrage, located in Sarawak, has been operating since 1998. Its primary function is to mitigate flood in Kuching. There have been several proposals to convert the flood-mitigating barrage into an energy-harvesting barrage by constructing a tidal power plant. Although the government supports green technology, the proposals have never been approved due to inevitable internal reasons. Therefore, this project is introduced in hopes that the government will eventually approve of this idea. There are four objectives in this project in which the most important parts are the selection of turbine type and analysis of its parameters. The turbine type selected is bulb turbine. Based on the analysis, it should have a diameter of 5.6 m and rated power of 3.75 MW. However, the turbine is too large to be installed at the barrage because the lowest depth of the river water is 4.7 m. Hence, a recommendation to overcome this hurdle is by proposing vortex turbine which is suitable for low head applications.

Keywords: Tidal power plant, Kuching barrage, Bulb turbine, Vortex turbine.

1. Introduction

This paper focuses mainly on the selection and study of low-head tidal turbine for the proposed tidal power plant at Kuching Barrage. A tidal barrage is a small-scale, dam-like structure used to capture the energy from masses of water moving in and out of a bay or river due to tidal forces. This technology had been introduced in Malaysia many years ago. Nonetheless, Kuching Barrage is not a tidal station, it is only used for flood control in Kuching. There were many researchers conducted to convert the barrage into a tidal station. However, none of the researches are being implemented and this has been ongoing for several years. This project is introduced in hopes that it will be used as a reference to assist in the implementation of the proposed tidal power plant at Kuching Barrage.

2. Literature Review

Tidal energy is a form of hydropower that converts the energy obtained from tides into electricity or other useful forms of power [1]. Conventionally, it involves constructing a barrage across the opening of a tidal basin. The barrage includes sluice gates that are used for allowing the movement of tide into the basin as the tide rises. The gates are then closed when the sea reaches its maximum level. When the sea level drops and reaches its lowest point, the gates are opened to allow the collected sea water in the basin to flow back into the sea. The water is forced to flow through tidal turbines which then convert the tidal energy into electrical energy.

2.1. Formation of Low and High Tides

In nature, the moon possesses gravitational attraction. Ocean tides respond to its gravitational pull as it orbits the Earth. The part of the Earth that is nearer to the moon is strongly attracted to the moon's gravitational pull as compared to the part that is farther from the moon. Hence, the close part gets closer to the moon and the far part gets farther, resulting in elongation of sea water in two directions. It also causes there to be two rising and receding tides for every 24 hours, 50 minutes, and 28 seconds (approximately 1 day). Since the moon rotates around the earth, the timing of these tides at any point on the earth will vary, occurring 50 minutes later each day.

2.2. Types of Hydropower Turbines

2.2.1. Impulse Turbine

Normally, to rotate an impulse turbine, the velocity of water is used, and it is discharged to atmospheric pressure. Each bucket on the runner is hit by the water stream. Usually, it is applicable for high head and low flowrate [2]. Pelton turbine and cross-flow turbine are types of impulse turbine.

2.2.2. Reaction Turbine

A reaction turbine harnesses power from the combined action of flowing water and pressure. It is submerged directly in the water stream, and water flows through the blades simultaneously, instead of striking each individually. It is commonly used for high water flowrate and lower head [2]. Types of reaction turbine are Francis turbine, kinetic turbine,